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COMMENTARY ON:

THE CLASSIFICATION OF ETS AS A CARCINOGEN

This document presents a rebuttal to the proposal of the Occupational Health Institute that environmental tobacco smoke (ETS) be included on the list of carcinogenous substances. The available scientific data do not adequately and convincingly support the classification of ETS as a carcinogen.

Section I analyzes the scientific issues involved in the classification of ETS as a carcinogen. Section II provides a critical review of various governmental reviews regarding the claimed carcinogenicity of ETS. Section III addresses smoking policy issues in light of the discussions in Sections I and II.

I. ANALYSIS OF SCIENTIFIC ISSUES

Several governmental and international health organizations have reviewed the literature regarding ETS.[1-4] These reviews are dependent upon two arguments. The first argument, called the epidemiologic argument, suggests that nonsmokers exposed to ETS are at increased risk for lung cancer, based upon positive associations reported in published epidemiologic studies on spousal smoking. The second argument, called the biological plausibility argument, depends upon the claim that mainstream smoke (the smoke

to which the active smoker is exposed) and ETS are similar mixtures, both of which contain carcinogenic substances.

Neither the epidemiologic argument nor the biologic plausibility argument is an accurate representation of the scientific data on ETS. Epidemiologic studies in the published literature which report an association between spousal smoking and chronic disease (e.g., lung cancer, heart disease, etc.) in nonsmokers are not based upon actual exposure assessments for ETS. Instead, "exposure" is assessed via questionnaire. The notions of "spousal smoking" or "living with a smoker" are used as surrogates to estimate ETS exposure.

Moreover, data on nonsmoker exposure to ETS are available elsewhere in the published literature.[5-39] These data are independent of the so-called "health effects" (epidemiologic) literature on ETS, and suggest that nonsmoker exposure to ETS in homes and typical public places and workplaces is minimal.[5-39] These low-level exposure data do not support the reports of increased risk from some epidemiologic studies on ETS.

In addition, the physical and chemical properties of ETS have been essentially ignored and/or misunderstood in the various governmental reviews on ETS.[40-47] The following presents a clarification of these scientific issues.

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A. THE EPIDEMIOLOGIC ARGUMENT

The claim that environmental tobacco smoke exposure increases the risk of lung cancer in nonsmokers is based upon positive associations reported in epidemiologic studies of nonsmoking women who report that their husbands smoked (spousal smoking).[2-4,48] The studies cited in support of the claimed association between spousal smoking and lung cancer have been heavily criticized in the scientific literature. As discussed above, none of the studies actually measured exposure to ETS. Moreover, the point estimates of risk reported in the studies are "weak" in epidemiologic terms (i.e., less than 3.0). Twenty-four of the 30 studies do not achieve statistical significance; that is, their conclusions are consistent with the null hypothesis of no association. Nine of the spousal smoking studies report point estimates that are negative (i.e., less than 1.0); one of these is statistically significant.

To date, 12 of the 30 published epidemiologic studies on the issue of spousal smoking and lung cancer in nonsmokers have assessed reported workplace exposures to ETS. Ten of the 12 studies report associations between ETS and nonsmoker lung cancer which do not achieve statistical significance; only two studies report marginally statistically significant increased risks for

persons who reported exposure to ETS in the workplace. **Thus, the existing data examining reported workplace ETS exposures and lung cancer incidence in nonsmokers are consistent with the null hypothesis of no association.**

A.1. QUESTIONNAIRE RELIABILITY:

All of the epidemiologic studies on the purported associations between living with a smoker and disease in nonsmokers rely solely upon questionnaire responses about reported exposure, rather than upon actual ETS exposure data. Recent studies indicate that questionnaires are an extremely unreliable and inaccurate measure of exposure.[49-55] Questionnaire responses about exposure vary widely when compared with actual measurements of ETS constituents in the ambient air.[50-51]

In 1983, Friedman et al. examined the accuracy of self-reported exposure to ETS.[53] They observed:

> Although the reported passive smoking of married persons was strongly related to their spouses' habits, categorization by spouses' smoking resulted in considerable misclassification.

Specifically, they reported:

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> Our data also indicate that studies of the effects of passive smoking should consider the correlates of this form of smoke exposure before concluding that it is responsible for some observed effect.
>
> However, using the spouse's smoking status to classify persons resulted, as far as can be discerned with our relatively crude questionnaire, in a considerable amount of misclassification. About 40-50 per cent of persons with nonsmoking spouses reported some passive exposure and, conversely, 30-35 per cent who were married to smokers surprisingly reported no exposure.

Pron et al.,[54] in a study on the reliability of self-reported ETS exposure histories, observed the following:

> Quantitative measures of exposure to passive smoke, i.e., number and duration of exposure, were even less reliably reported.
>
> Test-retest estimates of reliability suggest that misclassification of such exposures may be extensive.

They concluded:

> The results of this study suggest that improvements in the reliability of measurement of exposures to passive smoke are needed for future studies.

Most recently, the National Academy of Sciences, in their 1991 Report, "Human Exposure Assessment for Airborne Pollutants: Advances and Opportunities," addressed the validity of

questionnaires for exposure assessment in studies of ETS. The Report states:[55]

> It is important to examine ways to improve techniques to assess more accurately exposure to ETS.
>
> Until recently, epidemiological studies of the acute and chronic health effects of ETS have been handicapped by limitations in assessing exposures to ETS. Exposures occur at a wide range of concentrations for highly variable periods and in numerous indoor environments. Unlike active smoking, exposure to ETS cannot now be easily assessed with standardized methods. Previous epidemiological studies of the chronic effects of ETS, particularly lung cancer, have determined exposure solely by questionnaires, which have not been standardized or validated. The questionnaires have usually obtained information on smoking habits of occupants of residences to permit assessment of ETS exposures and have not adequately addressed the impact of occupational exposures. The use of such questionnaires might pose problems in misclassification of subjects by exposure status and obscure possible exposure-effect relationships.

Thus, epidemiologic data on spousal smoking do not provide convincing justification for the designation of ETS as a suspected carcinogen. The relative risks reported in such studies are low, the majority fails to achieve statistical significance, and all are based upon inaccurate exposure indices. In addition, the reported increased risks may be explained by reference to confounding factors such as lifestyle, diet, genetics and occupational exposures.

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Epidemiologic data on spousal smoking therefore do not provide a basis for classifying ETS as a human carcinogen.

B. THE ARGUMENT FROM BIOLOGICAL PLAUSIBILITY

The argument for the biological plausibility of ETS in disease causation depends upon the simplistic and inaccurate claim that since mainstream (MS) and sidestream (SS) smoke contain carcinogenic substances, so must ETS. However, this analogy is not proved.

B.1. ETS: A CHARACTERIZATION:

Environmental tobacco smoke (ETS) is an aged and dilute mixture of sidestream smoke (SS; the smoke from the burning end of the cigarette) and exhaled mainstream smoke (MS; the smoke to which the smoker is exposed). ETS differs chemically and physically from both MS and SS. ETS is a dynamic, ever-changing mixture which, as it ages and dissipates, undergoes chemical reactions and physical change. There is no single definable, reproducibly characterizable entity known as ETS.[40-47]

Dissipative forces such as air currents and attraction to surfaces influence SS and exhaled MS.[40-47] Studies indicate that constituents in ETS are hundreds to thousands of times more dilute

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than either SS or MS. Often, concentrations of ETS constituents fall below detection limits of current scientific measurement devices.

As ETS ages, a number of physico-chemical changes take place. Matter evaporates from SS particles as they age to ETS. During the aging process, ETS particles coagulate and increase in size. Chemical compounds partition between the gas and particle phase of the smoke. (For example, nicotine is found in the particle phase of MS; in fresh SS, most of the nicotine is in the gas phase.) Decay patterns for constituents of ETS vary over time and are dependent upon physical conditions in the environment.

ETS is not equivalent to either MS or SS. Many studies and reviews employ sidestream/mainstream smoke comparisons, ostensibly to demonstrate the kind and quantity of constituents involved in exposure to ETS. Such comparisons are deceptive and misleading. As two tobacco smoke chemists reported:[40]

> Although ETS originates from sidestream and exhaled mainstream smoke, the great dilution and other changes which these smoke streams undergo as they form ETS make their properties significantly different from those of ETS. Thus, the sidestream/mainstream ratios quoted in Table 1 can be misleading if used out of context. The important question is not the ratio of sidestream/mainstream but rather what is the concentration of the constituent in the indoor environment and how does it compare to levels from sources other than ETS. Studies

based solely on observations of fresh sidestream, or highly and unrealistically concentrated ETS, should take into account the possible differences between these smokes and ETS found in real-life situations.

Even the 1986 Report of the Surgeon General on ETS conceded:

> Comparison of the relative concentrations of various components of SS and MS smoke provides limited insights concerning the toxicological potential of ETS in comparison with active smoking. As described above, SS characteristics, as measured in a chamber, do not represent those of ETS, as inhaled by the non-smoker under non-experimental conditions.[2]

Similarly, the 1986 NAS/NRC Report on ETS concluded:

> Because the physicochemical nature of ETS, MS, and SS differ, the extrapolation of health effects from studies of MS or of active smokers to nonsmokers exposed to ETS may not be appropriate.[48]

B.2. EXPOSURE TO ETS:

Published studies indicate that nonsmoker exposure to ETS under normal, everyday conditions is minimal.[5-39] For example, researchers report that there is little difference in ambient levels of carbon monoxide in smoking and nonsmoking areas of workplaces and public places and in homes with and without smokers.[5-10] Other

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studies indicate that ETS contributes approximately 30% of the total particles in the air of a typical public place.*[5,12-17] Nicotine is often used as a marker for ETS exposures because it is unique to tobacco smoke. Typical measurements of nicotine range from an exposure equivalent of 1/100 to less than 1/1,000 of one filter cigarette per hour.[5,11-16,18-25] This means that a nonsmoker would have to spend from 100 to 1,000 hours or more in an office, restaurant or public place in order to be exposed to the nicotine equivalent of a single cigarette.

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* A paper published in a 1980 issue of Science magazine, in which the authors reported the results of their efforts to measure particles or particulates in the air of smoking and nonsmoking areas, is often cited to support the claim that ETS is a major indoor pollutant. The authors, Repace and Lowrey, contend that the levels of particles they observed in the smoking areas were much higher than in the nonsmoking areas. However, their study results are inconsistent with many others. For example, the average particle count attributed to ETS in their study was from three to twenty times higher than the average levels reported in other studies of office buildings, restaurants and residences.

There are a number of explanations for the authors' apparent overestimation of ETS exposure. First, they selectively sampled environments such as meeting and game rooms, bars, and sandwich shops which did not represent normal occupancy conditions and where particulate levels would likely be high regardless of the presence or absence of tobacco smoke. Second, through inappropriate testing methods, they incorrectly assumed all particles in the air arose from ETS. However, as several researchers have noted, ETS typically contributes about one-third of the overall particle levels in indoor spaces. Moreover, particles also are generated by people and their everyday routine activities such as movement and cooking. (Repace, J. and A. Lowrey, "Indoor Air Pollution, Tobacco Smoke and Public Health," Science 208: 464-472, 1980.)

For example, Drs. William Hinds and Melvin First of the Harvard School of Public Health reportedly found very small amounts of nicotine in the atmospheres of bars, bus and airline terminals, restaurants, and cocktail and student lounges.[18] French researchers, using a different method of measuring nicotine to assess the amount of tobacco smoke in the atmosphere, reported finding higher concentrations of nicotine than Hinds and First.[19] However, they still concluded that "smoking does not present a risk to nonsmokers."

Other studies have reached similar conclusions. In 1984, Japanese researchers tested a personal nicotine monitor in a number of public places, including offices, restaurants, lobbies, terminals and public transportation. They reported levels of nicotine exposure equivalent to one one-thousandth (1/1,000) to four one-hundredths (4/100) of a cigarette per hour.[21] Their findings were repeated in 1987.[22]

A year later, scientists from IT Corporation, a firm specializing in the assessment and reduction of environmental substances, measured nicotine in offices and restaurants in Ottawa, Canada.[11] They reported average nicotine exposure levels equivalent to three one-hundredths (3/100) of a cigarette per eight-hour workday, and three one-thousandths (3/1,000) of a cigarette during a one-hour meal.

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In a nationwide sampling survey in the United Kingdom, researchers monitored nearly 3,000 sites in travel, work, home and leisure locations for ambient nicotine, CO and particle levels.[5] Smoking was known to have occurred at almost half of those sites, yet in three-fourths of the samples, nicotine levels were too low to be detected. Canadian researchers also reported levels of nicotine at or below levels of detection even in locations with recirculated air from designated smoking areas.[13]

There are few data that suggest that the tiny amounts of nicotine to which a nonsmoker may be exposed are related to human disease. For example, two German scientists monitored several physiological responses in nonsmokers exposed to tobacco smoke under laboratory conditions.[56] They concluded that the amount of nicotine to which their subjects were exposed was too small to alter sensitive test measurements of heart rate, heart muscle tracings (EKG), blood pressure or skin temperature. More recent research tends to support these conclusions. In a 1983 study, researchers who measured exposures of nonsmoking flight attendants to nicotine during transpacific flights concluded that the concentrations were so small that they were "unlikely to have physiologic effects."[24] In 1986, researchers monitored levels of nicotine, CO and particulates in 66 commercial flights in the U.S. They concluded that the nonsmoking sections of commercial aircraft

were essentially free of ETS.[25]

The workplace exposure limit for ambient levels of nicotine set by various governmental agencies, including the U.S. Occupational Safety and Health Administration, is 500 ug/m^3. This occupational limit is one to two orders of magnitude higher than levels reported for typical ETS exposures. Indeed, in nonindustrial settings, studies indicate that typical nicotine concentrations due to ETS are less than 10 ug/m^3.[57]

In addition, studies which have examined ETS constituent levels of nitrosamines, nitrogen oxides and volatile organic compounds (such as benzene**) report minimal contributions to overall ambient air levels in homes, the workplace and public places.[26-39]

** Benzene exposure from ETS is negligible, despite reports to the contrary. "Automotive fuel is, by far, the largest, most pervasive source of benzene exposure. In 1989, the U.S. Department of Health and Human Services estimated that 1 billion pounds of benzene were released into the atmosphere from the refueling and operation of approximately 130 million motor vehicles in 1976 [NIEHS, 1989]. This translates into 7.8 pounds of benzene per vehicle per year. In contrast, a pack-per-day smoker would generate approximately 0.008 pounds of benzene per year, assuming that, at most, 0.5 mg of benzene is generated from one cigarette (MS plus SS) [Hoffmann, 1990]. Based on these estimates, an average person is potentially exposed to 1,000 times more ambient benzene from one automobile than from a smoker in a given year." [From: Response of R.J. Reynolds to the U.S. EPA: "ETS: A Guide to Workplace Smoking Policies," October 1, 1990.]

B.3. OTHER DATA CONTRARY TO THE ARGUMENT FROM BIOLOGIC PLAUSIBILITY:

ETS has never been shown to be carcinogenic in any animal species. Two animal inhalation experiments investigating ETS and lung cancer have been published. Both studies report no meaningful histopathological differences between animals exposed to ETS and those which were not exposed. In a study conducted by the American Health Foundation,[58-60] the investigators exposed one group of hamsters to mainstream smoke and another group to ETS. Animals exposed to mainstream smoke and ETS lived longer than the sham treated controls. The investigators reported that overall there was no marked increase in tumor incidence in animals exposed to either mainstream smoke or ETS after 18 months of exposure. The second study was a 90-day ETS inhalation study of rats and hamsters.[61] Animals were exposed to ETS concentrations 100 times greater than those concentrations reportedly encountered by nonsmokers. These researchers reported no histopathological differences between exposed and control animals. Electron microscopy revealed pulmonary changes which could be expected to occur under similar exposure conditions with other substances.

In addition, recent reviews of the literature on suspected pulmonary carcinogens have concluded that none of the individual constituents in sidestream smoke which are classified as potentially carcinogenic have been found to induce pulmonary

cancer via inhalation in experimental animals.[62-63]

Some reports have suggested that the potential toxicity of ETS can be assessed by measuring the body fluids of nonsmokers exposed to ETS for mutagens, which are substances capable of altering the genetic structure of cells.[64-66] It is suggested that the presence of mutagens in body fluids, such as urine, may indicate that an individual has been exposed to substances capable of inducing cancer. These studies, however, did not employ realistic levels of exposure to ETS. Nor did they control adequately for the presence of mutagenic substances in the diet of the study subjects. Studies which have compared mutagens in the body fluids of nonsmokers exposed to realistic levels of ETS and nonsmokers not exposed to ETS report no significant difference in mutagenic activity.[67-71]

Some have argued that sidestream smoke (and by inference, ETS) contains polycyclic aromatic hydrocarbons (PAHs), substances which have been designated as carcinogens or cancer-causing by various governmental agencies. However, in a series of papers, German researchers reported finding no significant differences in urinary PAH by-products between nonsmokers exposed to ETS and those not exposed.[72-74] Diet, on the other hand, was reported to have a profound influence on PAH by-product formation in all the study subjects.

It has also been suggested that DNA adducts can be utilized as biomarkers to assess exposure to ETS. (An adduct is a product derived from reactions between chemicals and biological material, such as DNA, the genetic material in the body). Research, however, does not support this theory; nonsmokers exposed to ETS do not appear to exhibit increased DNA adduct production.[75] Other studies report no increased chromosomal changes in the body fluids of nonsmokers exposed to ETS.[65,71,76]

Finnish researchers recently have published on the ETS/genotoxicity issue. Their reports seriously question the legitimacy of the claim that ETS is a carcinogen. In a series of published papers, the researchers examined urinary mutagenicity and sister chromatid exchange (SCE) frequency as potential genotoxic indicators of ETS exposure.[47,69,70-71,76] They have reported that these parameters of genotoxic exposure do not respond significantly to normally encountered levels of ETS. In one such study, the researchers reported that cytogenetic parameters (structural chromosome aberrations and SCE) were unaffected by normal nonsmoker exposure to ETS.[76]

The report by Husgafvel-Pursiainen (1987) cited in the Occupational Health Institute's submission deserves special mention.[65] This report concludes that while certain markers of

nonsmoker exposure may increase in the presence of extremely high concentrations of ETS, the exposure levels in the paper do not match those attributed to it by the Occupational Health Institute's submission. Moreover, this report, like others from Husgafvel-Pursiainen (and Sorsa), concludes that there is no significant increased mutagenic activity in body fluids of those exposed to ETS compared with those not exposed.[71,76]

Because of the vast quantitative and qualitative differences (chemical and physical properties) among mainstream smoke, sidestream smoke and ETS, the basis of the biological plausibility argument is flawed. Data reveal that nonsmoker exposure and dose estimates are many orders of magnitude lower than those of active smokers. Animal inhalation studies and short-term tests (e.g., urinary mutagenicity, sister chromatid exchange, etc.) in humans provide no supportive data for the "biological plausibility" claim. And finally, linear extrapolation models based on active smoking fail to predict increased risk for nonsmokers exposed to realistic levels of ETS.

REFERENCES

1. World Health Organization, International Agency for Research on Cancer, IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: Tobacco Smoking, Volume 38, Lyon, 1985.

2. U.S. Department of Health and Human Services, Public Health Service, Office on Smoking and Health, The Health Consequences of Involuntary Smoking: A Report of the Surgeon General. DHHS Publication No. (CDC) 87-8398, Washington, D.C., U.S. Government Printing Office, 1986.

3. U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Office of Atmospheric and Indoor Air Programs, Health Effects of Passive Smoking: Assessment of Lung Cancer in Adults and Respiratory Disorders in Children, External Review Draft, EPA/600/6-90/006A, May, 1990.

4. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Current Intelligence Bulletin 54: Environmental Tobacco Smoke in the Workplace: Lung Cancer and Other Health Effects. DHHS (NIOSH) Publication No. 91-108, Cincinnati, Ohio, June, 1991.

5. Kirk, P., et al., "Environmental Tobacco Smoke in Indoor Air." In: Indoor and Ambient Air Quality. R. Perry and P. Kirk (eds.). London, Selper Ltd., 99-112, 1988.

6. Duncan, D. and Greavey, P., "Passive Smoking and Uptake of Carbon Monoxide in Flight Attendants," JAMA 251(20): 120-21, 1984.

7. Cox, B. and Whichelow, M., "Carbon Monoxide Levels in the Breath of Smokers and Nonsmokers: Effect of Domestic Heating Systems," J Epidemiol Community Health 39: 75-78, 1985.

8. Girman, J. and Traynor, G., "Indoor Concentrations," JAPCA 33(2): 89, 1983.

9. Yocom, J., "Indoor Concentrations," JAPCA 33(2): 89, 1983.

10. Nitta, H., et al., "Measurements of Indoor Carbon Monoxide Levels Using Passive Samplers in Korea." In: Indoor Air '90. The Fifth International Conference on Indoor Air Quality and Climate, Toronto, Canada, July 29-August 3, 77-82, 1990.

11. Carson, J. and Erikson, C., "Results from Survey of Environmental Tobacco Smoke in Offices in Ottawa, Ontario," Environ Technol Letters 9: 501-508, 1988.

12. Sterling, T., et al., "Environmental Tobacco Smoke and Indoor Air Quality in Modern Office Work Environments," Journal of Occupational Medicine 26(1): 57-62, 1987.

13. Sterling T. and Mueller, B., "Concentrations of Nicotine, RSP, CO and CO_2 in Nonsmoking Areas of Offices Ventilated by Air Recirculated From Smoking Designated Areas," Am Ind Hyg Assoc J 49(9): 423-426, 1988.

14. Hosein, R., "The Relationship Between Pollutant Levels in Homes and Potential Sources." In: Indoor Air Quality in Cold Climates, Hazards and Abatement Measures. D. Walkinshaw (ed.). APCA, Ottawa, Ontario, 250-260, 1985.

15. Proctor, C., et al., "Measurements of Environmental Tobacco Smoke in an Air-Conditioned Office Building," Environ Technol Letters (10): 1003-1018, 1989.

16. Oldaker, G., et al., "Results From Surveys of Environmental Tobacco Smoke in Restaurants." In: Indoor Air Quality. H. Kasuga (ed.). Springer-Verlag, Berlin, Heidelberg, 99-104, 1990.

17. Quackenboss, J. and Lebowitz, M., "Indoor-Outdoor Relationships for Particulate Matter: Exposure Classifications and Health Effects," Environ Int 15: 353-360, 1989.

18. Hinds, W. and First, M., "Concentrations of Nicotine and Tobacco Smoke in Public Places," New England Journal of Medicine 292(16): 844-845, 1975.

19. Badre, R., et al., "Pollution Atmospherique par la Fumee de Tabac (Atmospheric Pollution by Smoking)," Ann Pharm Fr 36(9-10): 443-452, 1978. Translation.

20. Jenkins, R., et al., "Development and Application of a Thermal Desorption-Based Method for the Determination of Nicotine in Indoor Environments." In: Indoor and Ambient Air Quality. R. Perry and P. Kirk (eds.). London, Selper Ltd., 557-566, 1988.

21. Muramatsu, M., et al., "Estimation of Personal Exposure to Tobacco Smoke with a Newly Developed Nicotine Personal Monitor," Environ Res 35: 218-227, 1984.

2501049772

22. Muramatsu, M., et al., "Estimation of Personal Exposure to Ambient Nicotine in Daily Environment," Arch Occup Environ Health 59: 545-550, 1987.

23. Thompson, C., et al., "A Thermal Desorption Method for the Determination of Nicotine in Indoor Environments," Envir Sci Tech 23: 429-435, 1989.

24. Foliart, D., et al., "Passive Absorption of Nicotine in Airline Flight Attendants," New England Journal of Medicine 308(18): 1105, 1983.

25. Oldaker, G. and Conrad, F., "Estimation of the Effect of Environmental Tobacco Smoke on Air Quality Within Passenger Cabins of Commercial Aircraft," Envir Sci Tech 21: 994-999, 1987.

26. Lehnert, G., "Conclusion: In the Realm of Speculation," Munch med Wschr 124(4), 1982.

27. Schievelbein, H., "Are There Really Important New Findings About Passive Smoking?," Oeff Gesundheitswes 44(0): 454-56, 1982. Translation.

28. Stehlik, G., et al., "Concentration of Dimethylnitrosamine in the Air of Smoke-Filled Rooms," Ecotoxicol Environ Safety 6: 495-500, 1982.

29. Sega, K. and Fugas, M., "Nitrogen Dioxide Concentrations in Residences." In: Indoor and Ambient Air Quality. R. Perry and P. Kirk (eds.). London, Selper Ltd., 493-496, 1988.

30. Good, B., et al., "Effect of Cigarette Smoking on Residential NO_2 Levels," Environ Int 8: 167-175, 1982.

31. Shimizu, Y., et al., "Influence of Indoor Air Pollution on NO_2 Personal Exposure Levels of Schoolchildren." In: Present and Future of Indoor Air Quality. C. Bieva, et al. (eds.). Brussels, Elsevier, 337-345, 1989.

32. Hendel-Kramer, A., et al., "Regression Model for Indoor Concentrations of Combustion-Generated Gases." In: Present and Future of Indoor Air Quality. C. Bieva, et al. (eds.). Brussels, Elsevier, 315-320, 1989.

33. Bayer, C. and Black, M., "Thermal Desorption/Gas Chromatographic/Mass Spectrometric Analysis of Volatile Organic Compounds in the Offices of Smokers and Nonsmokers," Biomed and Envir Mass Spect 14(8): 363-367, 1987.

2501049773

34. Proctor, C., et al., "Measurements of Environmental Tobacco Smoke in an Air-Conditioned Office Building," Environ Technol Letters (10): 1003-1018, 1989.

35. Godish, T., "Formaldehyde Exposures from Tobacco Smoke: A Review," AJPH 79(8): 1044-1045, 1989.

36. Godish, T., "Residential Formaldehyde: Increased Exposure Levels Aggravate Adverse Health Effects," Journal of Environmental Health 53(3): 34-35, 1990.

37. Adlkofer, F., et al., "Significance of Exposure to Benzene and Other Toxic Compounds Through Environmental Tobacco Smoke," J Cancer Res Clin Oncol (116): 591-598, 1990.

38. Hugod, C., et al., "Exposure of Passive Smokers to Tobacco Smoke Constituents," Int Arch Occup Environ Health (42): 21-29, 1978.

39. Proctor, C., et al., "Measurement of Environmental Tobacco Smoke in an Air-Conditioned Office Building." In: Present and Future of Indoor Air Quality. C.J. Bieva, et al. (eds.). Brussels, Elsevier, 169-172, 1989.

40. Baker, R. and Proctor, C., "The Origins and Properties of Environmental Tobacco Smoke," Env Int (16): 231-245, 1990.

41. Löfroth, G., et al., "Characterization of Environmental Tobacco Smoke," Env Sci Technol (23): 610-614, 1989.

42. Reasor, M. and Will, J., "Assessing Exposure to Environmental Tobacco Smoke: Is It Valid to Extrapolate from Active Smoke?," Journal of Smoking Related Diseases 2(1): 111-127, 1991.

43. Proctor, C. and Dymond, H., "The Measurement of ETS Through Adsorption/Desorption Procedures." In: Indoor Air Quality. H. Kasuga (ed.). Springer-Verlag, Berlin, Heidelberg, 82-89, 1990.

44. Nystrom, C., et al., "Assessing the Impact of Environmental Tobacco Smoke on Indoor Air Quality: Current Status." In: Proceedings of the ASHRAE Conference, IAQ '86. April 20-23, 1986, Atlanta, Georgia, 213-233, 1986.

45. Rawbone, R., "The Aging of Sidestream Tobacco Smoke Components in Ambient Environments." In: Indoor Air Quality. H. Kasuga (ed.). Springer-Verlag, Berlin, Heidelberg, 55-61, 1990.

2501049774

46. Piade, J., et al., "Assessment of ETS Impact on Office Air Quality." In: Indoor Air Quality. H. Kasuga (ed.). Springer-Verlag, Berlin, Heidelberg, 112-119, 1990.

47. Scherer, G., et al., "Importance of Exposure to Gaseous and Particulate Phase Components of Tobacco Smoke in Active and Passive Smokers," Occup Env Health (62): 459-466, 1990.

48. Committee on Passive Smoking, Board on Environmental Studies and Toxicology, National Research Council, Environmental Tobacco Smoke, Measuring Exposures and Assessing Health Effects. National Academy Press, Washington, D.C., 7-8, 1986.

49. Coultas, D., et al., "Questionnaire Assessment of Lifetime and Recent Exposure to Environmental Tobacco Smoke," American Journal of Epidemiology 130(2): 338-347, 1989.

50. Coultas, D., et al., "Variability of Measures of Exposure to Environmental Tobacco Smoke in the Home," American Review of Respiratory Disease 142: 602-606, 1990.

51. Coultas, D., et al., "A Personal Monitoring Study to Assess Workplace Exposure to Environmental Tobacco Smoke," American Journal of Public Health 80(8): 988-990, 1990.

52. Tager, I., "Health Effects of Involuntary Smoking in the Workplace," New York State Journal of Medicine 89(1): 27-31, 1989.

53. Friedman, G. et al., "Prevalence and Correlates of Passive Smoking," American Journal of Public Health 73(4): 401-405, 1983.

54. Pron, G. et al., "The Reliability of Passive Smoking Histories Reported in a Case-Control Study of Lung Cancer," American Journal of Epidemiology 127(2): 267-273, 1988.

55. National Academy of Sciences, National Research Council, Committee on Advances in Assessing Human Exposure to Airborne Pollutants, Human Exposure Assessment for Airborne Pollutants: Advances and Opportunities, National Academy Press, Washington D.C., 215-216, 1991.

56. Harke, H. and Bleichert, A., "Zum Problem des Passivrauchens (On the Problem of Passive Smoking)," Int Arch Arbeitsmed 29: 312-333, 1972. Translation.

57. Guerin, M., et al., The Chemistry of Environmental Tobacco Smoke: Composition and Measurement. (Lewis Publishers: Chelsea, Michigan, 1992): 137-158.

2501049775

58. Haley, N., et al., "Uptake of Sidestream Smoke by Syrian Golden Hamsters," Toxicol. Letters 35 (1987): 83-88.

59. Haley, N., "Sidestream Smoke Uptake By Syrian Golden Hamsters in An Inhalation Bioassay," Indoor Air '87: Proceedings of the 4th International Conference on Indoor Air Quality and Climate, Institute for Water, Soil and Air Hygiene, Berlin: 68-73, 1987.

60. American Health Foundation, "Experimental Tobacco Carcinogenesis," Application for Continuation Grant to Department of Health and Human Services, U.S. Public Health Service, May 1988.

61. Adlkofer, F., et al., "Exposure of Hamsters and Rats to Sidesteam Smoke of Cigarettes: Preliminary Results of a 90-Day-Inhalation Study," Indoor and Ambient Air Quality, eds. R. Perry and P. Kirk, London, Selper Ltd.: 252-258, 1988.

62. Aviado, D., "Suspected Pulmonary Carcinogens in Environmental Tobacco Smoke," Environ. Tech. Letters, 9: 539-544, 1988.

63. Aviado, D., "Health Effects of 50 Selected Constituents of Environmental Tobacco Smoke," Indoor Air Quality, ed. H. Kasuga, Springer-Verlag, Berlin Heidelberg: 383-389, 1990.

64. Bos, R., et al., "Excretion of Mutagens in Human Urine After Passive Smoking," Cancer Letters (19): 85-90, 1983.

65. Husgafvel-Pursiainen, K., et al., "Passive Smoking at Work: Biochemical and Biological Measures of Exposure to Environmental Tobacco Smoke," Int Arch Occup Environ Health (59): 337-345, 1987.

66. Mohtashamipur, E., et al., "Urinary Excretion of Mutagens in Passive Smokers," Toxicology Letters (35): 141-146, 1987.

67. Scherer, G., et al., "Urinary Mutagenicity After Controlled Exposure to Environmental Tobacco Smoke (ETS)," Toxicology Letters 35(1): 135-140, 1987.

68. Bombick, D., et al., "Assessment of the Biological Activity of Mainstream or Environmental Tobacco Smoke (ETS) Using a Cellular Smoke Exposure Technique," Abstracts of the Twenty-Second Annual Scientific Meeting of the Environmental Mutagen Society, Kissimmee, Florida, April 6-11, 1991.

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69. Scherer, G., "Biomonitoring of Exposure to Potentially Genotoxic Substances From Environmental Tobacco Smoke," Environ Int (15): 49-56, 1989.

70. Scherer, G., "Quantitative and Qualitative Differences in Tobacco Smoke Uptake Between Active and Passive Smoking." In: Indoor and Ambient Air Quality. R. Perry and P. Kirk (eds.). London, Selper Ltd., 189-194, 1988.

71. Sorsa, M. and K. Husgafvel-Pursiainen, "Assessment of Passive and Transplacental Exposure to Tobacco Smoke, Methods for Detecting DNA Damaging Agents in Humans: Applications in Cancer Epidemiology and Prevention," IAKC Scientific Publications No. 89, (IARC, Lyon, France, 1988): 129-132.

72. Scherer, G., et al., "Urinary Mutagenic, Hydroxy-Phenanthrene, and Thioether Excretion After Exposure to Environmental Tobacco Smoke." In: Indoor Air Quality, H. Kasuga (ed.). Berlin, Heidelberg, Springer-Verlag, 138-146, 1990.

73. Martin, F., et al., "Urinary Excretion of Hydroxy-Phenanthrenes After Intake of Polycyclic Aromatic Hydrocarbons," Environ Int (15): 41-47, 1989.

74. Hoepfner, H., et al., "Hydroxy-Phenanthrenes in the Urine of Non-Smokers and Smokers," Toxicology Letters (35): 67-71, 1987.

75. Holz, O., et al., "^{32}P-postlabelling Analysis of DNA Adducts in Monocytes of Smokers and Passive Smokers," Int Arch Occup Environ Health, 62: 299-303, 1990.

76. Sorsa, M., et al., "Cytogenetic Effects of Tobacco Smoke Exposure Among Involuntary Smokers," Mutation Res 222(2): 111-116, 1989.

II. AGENCY REVIEWS OF ETS

The conclusions of reports by four* governmental and international agencies have been relied upon extensively by various organizations and individuals in discussions regarding the argument of ETS as a carcinogen. These reports are:

[1] The Health Consequences of Involuntary Smoking,[1] a 1986 report of the Surgeon General (hereinafter 1986 Surgeon General's Report);

[2] Health Effects of Passive Smoking: Assessment of Lung Cancer in Adults and Respiratory Disorders in Children (EPA/600/6-90/006A),[2] a review draft released by the Environmental Protection Agency (EPA) in 1990 (Draft Risk Assessment);

[3] Environmental Tobacco Smoke in the Workplace: Lung Cancer and Other Health Effects,[3] a Current Intelligence Bulletin

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* ~~The U.S. NAS/NRC study on ETS (1986) did not designate ETS~~ as a carcinogen per se although its conclusions were ~~similar~~ in other ~~respects~~ to the 1986 U.S. ~~Surgeon General's~~ Report. [See: Committee ~~on~~ Passive Smoking, Board of Environmental Studies and Toxicology, ~~National~~ Research Council, National Academy of Sciences, ~~Environmental Tobacco Smoke: Measuring Exposures and Assessing Health Effects~~. ~~Washington, D.~~C., ~~National~~ Academy Press, 1986.]

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issued by the National Institute for Occupational Safety and Health in 1991 (NIOSH CIB); and

[4] World Health Organization, International Agency for Research on Cancer, IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: Tobacco Smoking,[4] Volume 38, Lyon, 1985 (IARC Report).

It is important to note that each of the respective Agency's discussions of ETS was based upon the imputed identification and presence of suspected carcinogens in mainstream smoke and/or fresh sidestream smoke (smoke from the burning tip of the cigarette). The IARC, the U.S. Surgeon General, the EPA and NIOSH did not examine ETS per se, nor did they review the available published data on either the characterization of, or exposure to, ETS. As was discussed in Section I of this document, ETS is neither chemically nor physically equivalent to either mainstream or sidestream smoke, and it is therefore not scientifically acceptable to treat mainstream smoke, sidestream smoke and ETS as qualitatively and quantitatively similar mixtures.

A recent classification of tobacco smoke as a "human carcinogen" was proffered by the U.S. EPA in its 1990 Draft Risk Assessment.[2] The Draft was heavily criticized and challenged by a number of scientists, most notably for its uncritical reliance on

epidemiologic studies and for its failure to examine other relevant data on actual ETS exposures and the chemical/physical characterization of ETS.[5] As Dr. Arthur Furst has recently argued: "the decision to classify a chemical as a human carcinogen must depend upon agreed conclusions from epidemiology, bioassays and some short-term tests; information from only one of these disciplines is inadequate."[6]

IARC, in its ~~classification~~ review, conceded that ETS is not equivalent to either mainstream or sidestream smoke and that the epidemiologic data on disease rates among nonsmokers living with smokers are inconclusive. The Agency based its classification, in large part, not upon ETS per se but upon imputed "knowledge of the nature of mainstream and sidestream smoke."[4]

In similar fashion, the recent U.S. NIOSH Current Intelligence Bulletin's ~~classification~~ discussion of ETS as "a potential occupational carcinogen" was not based upon a critical examination of the physico-chemical composition of ETS per se, or upon any data regarding workplace exposures to ETS or associations between reported exposures and claimed health effects among nonsmokers in the workplace.[3] If the actual data on both ETS exposures and health effects in the workplace are examined, one finds that typical workplace exposures to ETS are minimal and often below limits of detection for even the most sensitive tobacco smoke constituent

monitors. In addition, only two of twelve studies which have examined the possible association between reported ETS exposures and chronic disease (e.g., lung cancer, heart disease, etc.) among nonsmoking workers report statistically significant increased risks.

The Occupational Health Institute's report also referred to a recent legal decision in Australia for support.[7] The court ruled in favor of the Australian Federation of Consumer Organizations (AFCO) in its allegation that a July 1986 advertisement on ETS by the Tobacco Institute of Australia (TIA) was false and "misleading and deceptive" under that country's Trade Practices Act. The case centered around the TIA's statement in the ad that "there is little evidence and nothing which proves scientifically that cigarette smoke causes disease in nonsmokers."[7] The Tobacco Institute of Australia has appealed the decision on the basis that their statement is "an opinion which has a rational scientific basis."[8]

The AFCO opinion was rendered by a single justice of the Federal Court of Australia against the requirements of a specific trade regulation statute in Australia. Although expert scientific testimony on ETS was heard during the trial, the decision is not a scientific opinion; it generates no new data on the issue of ETS.

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The Occupational Health Institute's report cites two booklets published recently in the United Kingdom, one entitled "Passive Smoking at Work" (HSE 1988) and the other, "Passive Smoking -- A Health Hazard" (Imperial Cancer Research Fund 1991), for support of its argument for workplace smoking restrictions. However, neither publication presents new scientific data on the workplace smoking issue and neither presents an analysis of the existing epidemiologic and exposure data regarding ETS in the workplace. As discussed in Part I of this submission, typical workplace exposures to ETS are minimal and often below the levels of detection for ambient air quality monitoring devices. Moreover, there are twelve published epidemiologic studies which examine workplace exposures to ETS and lung cancer in nonsmokers, and ten of those studies report no statistically significant increased risk of lung cancer in nonsmokers. The epidemiologic data on workplace exposures to ETS are thus consistent with the null hypothesis, i.e. that there is no association between workplace ETS exposure and lung cancer in nonsmokers. Neither of the British reports adequately support the claim that workplace exposures to ETS are associated with an increased risk of disease among nonsmokers and the publications therefore fail to provide a convincing argument for workplace smoking restrictions.

1. 1986 SURGEON GENERAL'S REPORT

The EPA draft risk assessment and the NIOSH CIB rely extensively on the conclusions of the 1986 Surgeon General's Report on "Involuntary Smoking," the U.S. Public Health Service's eighteenth report, and the fifth report issued during the tenure of C. Everett Koop. The 1986 Surgeon General's Report reached two ~~major~~ conclusions which ~~some may~~ the Occupational Health Institute has urged are relevant to the ETS classification issue:

> Involuntary smoking is a cause of disease, including lung cancer, in healthy nonsmokers. (p. vii)
>
> The simple separation of smokers and nonsmokers within the same air space may reduce, but does not eliminate, the exposure of nonsmokers to environmental tobacco smoke. (p. vii)

The Surgeon General's review has been challenged by a number of critics. One reviewer, Ann Fettner, suggested that the Surgeon General's conclusions were based on "flimsy" evidence presented in an effort to "divert our attention" from important health concerns such as the "poisoning of the environment."[9] A U.S. Congressman, Walter B. Jones, in a letter published in the Congressional Record, wrote that "the conclusions in the Surgeon General's Report are not supported by the research in his own report."[10] The Surgeon General's conclusions regarding lung cancer

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and separation of smokers and nonsmokers will be discussed below in some detail.

1.a. LUNG CANCER:

The Surgeon General's conclusion that a causal relationship exists between ETS exposure and lung cancer in nonsmokers was based on 13 epidemiologic studies of women whose husbands smoked. Of those studies, eleven reported risk estimates that were not statistically significant.[11] Moreover, scientific deficiencies in the epidemiologic studies on ETS and nonsmoker lung cancer have been identified by numerous individuals. A German specialist in biometrics and epidemiology, Karl Uberla, in his assessment of these studies, suggested that the data fail to meet the criteria which some regard as necessary to establish a causal relationship:[12]

> The majority of criteria for a causal connection are not fulfilled. There is no consistency, there is a weak association, there is no specificity, the dose-effect relation can be viewed controversially, bias and confounding are not adequately excluded, there is no intervention study, significance is only present under special conditions and the biologic plausibility can be judged controversially.

An eminent American statistician, Nathan Mantel, has also observed:[13]

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> [I]t is unlikely that any epidemiological study has been, or can be, conducted which could permit establishing that the risk of lung cancer has been raised by passive smoking. Whether or not the risk is raised remains to be taken as a matter of faith according to one's choice.

There are currently 30 spousal smoking studies, 24 of which report risk estimates that are not statistically significant.[14-43] Only six studies report statistically significant increased lung cancer risks for women whose husbands smoke. Thus, these studies taken as a group, or considered individually, do not convincingly support rejection of the null hypothesis of no association between ETS exposure and lung cancer in nonsmokers, and therefore are inadequate as a basis for classification.

Moreover, the vast majority of the spousal smoking studies report risk estimates that are less than 2.0. These values are at the limit of detection for epidemiology. Risk estimates below 2.0 or 3.0 have been described as "weak," and thus, any conclusions drawn from such studies are unreliable.[44] This is particularly true when the studies themselves fail to account for numerous sources of bias and confounding factors. The confounding factors are variables associated with both the classification of "marriage to a smoker" and with risk factors associated with lung cancer, the existence of which can give rise to a spurious ETS-lung cancer association. Examples of confounding factors that are not

controlled for in the studies include diet, alcohol consumption, cooking and heating methods, occupation, physical activity, urbanization and socioeconomic class.[45]

In addition, application of spousal smoking studies to the workplace presents significant questions. Even the Surgeon General conceded that "[m]ore accurate estimates for the assessment of exposure in the home, workplace, and other environments are needed" (p. 101).[1]

In fact, the epidemiologic studies on lung cancer and respiratory disease cited in the Surgeon General's Report did not include any actual measurements of study subjects' exposure to ETS in either the home or the workplace. Instead, the studies relied on questionnaire information to estimate exposure to ETS. The Surgeon General's Report itself acknowledges that the "possibility of reporting bias must be considered for the studies that have used questionnaires to measure illness experience" (p. 38). A number of researchers have reported that exposure misclassification can lead to improper indices of exposure and incorrect estimations of risk.[15,46-51] The Surgeon General's Report also concedes that "validated questionnaires are needed for the assessment of recent and remote exposure to environmental tobacco smoke in the home, workplace, and other environments" (p. 107).[1] The National Research Council and other authors have recently

criticized questionnaires used in ETS studies for not being standardized or validated, pointing out that misclassification of exposure may occur if the questionnaire is not appropriately designed.[52-54]

1.b. SEPARATION OF SMOKERS AND NONSMOKERS:

The Surgeon General's Report also concluded that "simple separation of smokers and nonsmokers within the same air space may reduce, but does not eliminate, exposure of nonsmokers to environmental tobacco smoke" (p. vii). The Report concludes that smoking bans will not only reduce ETS exposures, but will also "alter smoking behavior and public attitudes about tobacco use" (p. 322). The Report further suggests that "over time, this may contribute to a reduction of smoking in the United States" (p. 322). Thus, the underlying motivation for the use of the ETS/health argument is to attain a "smoke-free society by the year 2000."

The Surgeon General's claim that separation of smokers and nonsmokers does not minimize nonsmoker exposure to ETS is without scientific support. Studies aboard commercial aircraft and in offices indicate, contrary to the Surgeon General's Report, that the simple separation of smokers and nonsmokers effectively minimizes nonsmoker exposure to ETS.[55-62] One recent study, for example, reported that the use of designated smoking areas reduced

exposure to ETS by 95 percent.[55] Another study of a smoking-restricted office building reported that ambient nicotine in nonsmoking areas was virtually undetectable, suggesting that ETS had a negligible impact on the nonsmoking areas in the building.[56] In addition, Canadian researchers Sterling, et al., in a series of studies, collected data on levels of ETS constituents in offices with different smoking policies. They reported no significant differences in average ETS constituent levels between nonsmoking offices that received recirculated air from designated smoking areas and nonsmoking offices that did not receive recirculated air.[57-58,62] They concluded:

> The results indicate that the provision of a designated, but not separately ventilated smoking area can effectively eliminate or drastically reduce most components of environmental tobacco smoke from nonsmoking offices.

In summary, the Surgeon General's claims that exposure to ETS increases the risk of lung cancer in nonsmokers and that simple separation of smokers and nonsmokers is ineffective in minimizing exposure are not convincingly supported by the scientific data and should not be used as a basis for workplace smoking policy decisions.

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2. EPA DRAFT RISK ASSESSMENT

In June, 1990, the United States Environmental Protection Agency (EPA) released for review its Draft Risk Assessment on ETS.[2] The Draft Risk Assessment concluded that exposure to ETS is causally related to lung cancer in adult nonsmokers and is associated with respiratory disease and respiratory symptoms in children. The Draft Risk Assessment also concluded that ETS should be classified as a Group A ("known human") carcinogen. It estimated that ETS exposures are responsible for 3,800 lung cancer deaths per year in the U.S. (the estimate was later revised to 3,700).

The Draft Risk Assessment employed a Population-Attributable Risk model for estimating excess lung cancer mortality among nonsmokers reportedly exposed to ETS.[2] This model is based upon three estimates:

1. a point estimate or relative risk derived from a meta-analysis of epidemiologic studies on spousal smoking;
2. the proportion of nonsmokers reportedly exposed to ETS; and
3. the number of nonsmokers in the general population.

To calculate the Population-Attributable Risk (PAR), the authors of the Draft Risk Assessment estimated that 60% of

nonsmokers are exposed to ETS. A cumulative relative risk of 1.28 was calculated via meta-analysis from epidemiologic studies on spousal smoking as the excess risk due to ETS exposure. The PAR for these two assumptions is 0.27. The total number of deaths for nonsmoking males and females was then estimated, based on the American Cancer Society's projections for 1988 (9,500 total deaths). By multiplying the PAR (0.27) by 9,500, the authors generated an estimate of 2,560 total deaths per year attributable to ETS exposure among neversmokers. A PAR was also computed for male and female former smokers, generating a total estimate of 3,800 excess deaths annually purportedly attributable to ETS exposure among nonsmokers in the U.S.

The PAR method employs estimates of relative risk, population fractions of exposure to ETS and lung cancer death rates for the general nonsmoking population in order to generate an estimate of excess mortality reportedly attributable to ETS exposure. It is important to note at the outset that the PAR model itself does not determine that there is an increased risk of lung cancer among nonsmokers from ETS exposure. Rather, the model assumes a causal relationship between ETS exposure and an increased risk of lung cancer among nonsmokers, based upon increased risks reported in epidemiologic studies on spousal smoking. These reported relative risks are, in turn, assumed to represent true relative risks due to ETS exposure.

These critical assumptions have been challenged.[63] To achieve a cumulative excess risk estimate of 1.28 for nonsmokers reportedly exposed to ETS, the authors of the Draft Risk Assessment performed a meta-analysis of 23 epidemiologic studies on spousal smoking. However, eighteen of the studies on spousal smoking included in the EPA's meta-analysis fail to achieve statistical significance and are, therefore, consistent with the null hypothesis of no association between spousal smoking and an increased risk of lung cancer among nonsmokers. Moreover, the epidemiologic studies on spousal smoking contain no actual exposure data on ETS. The EPA Draft instead assumed the validity of questionnaire responses about possible exposure to ETS based upon spousal smoking and then generalized these responses to the general population's exposure to ETS. Finally, the authors of the Draft Risk Assessment failed to consider and adjust for confounding factors, e.g., diet, lifestyle, genetics, etc., in any of the individual studies on spousal smoking. This is a significant oversight, especially when dealing with a "weak" relative risk estimate which approximates 1.3.

The Draft's assumption of causality is based upon tenuous data from epidemiologic studies on spousal smoking. The assumption is the critical element to the PAR model and the estimate of 3,800 excess nonsmoker deaths per year reportedly due to ETS exposure. The Draft Risk Assessment fails to argue convincingly for the

assumption. Without the causal assumption, the PAR approach is little more than an exercise in mathematical modeling.

Furthermore, the conclusions of the Draft Risk Assessment have been strongly criticized, particularly in many of the more than 100 comments submitted during the public comment period on the draft.[63] Specifically, many of the public comments found EPA's classification of ETS as a Group A carcinogen to be scientifically unwarranted.

EPA's proposed classification of tobacco smoke as a "human carcinogen" was based in part upon the imputed identification and presence of suspected carcinogens in mainstream smoke and/or fresh sidestream smoke. However, the EPA apparently did not review the available published data on either the characterization of, or exposure to, ETS.[64-69]

As discussed above, meta-analysis, a statistical procedure which combines the reported risk estimates from a number of studies to generate an overall estimate of risk, was used in the EPA's Population-Attributable Risk model. The problems and limitations of the use of meta-analysis for epidemiologic studies have been addressed in the scientific literature.[70-71] For instance, meta-analysis does not account for intrinsic bias and confounding in the individual studies. As two German scientists, Heinz Letzel

and Karl Uberla, noted: "Combining risk estimates from biased or confounded studies by meta-analysis cannot provide correct answers."[71] The spousal smoking studies were conducted in the United States, Europe and Asia. These populations differ genetically and in lifestyle factors, and the studies themselves differ in design.[70]

Another major criticism of the Draft Risk Assessment was that in addition to its inadequate treatment of the data on the physical and chemical properties of ETS, it also virtually ignored the available exposure data, toxicological data and data from animal studies on ETS.

Thus, the conclusions of the EPA's Draft Risk Assessment are based on an incomplete and selective review of the existing data on ETS. Several of the public comments suggested that this amounted to EPA's apparent failure to follow its own guidelines for carcinogen risk assessment.[63]

3. NIOSH CURRENT INTELLIGENCE BULLETIN

In June 1991, NIOSH released Current Intelligence Bulletin 54 on environmental tobacco smoke.[3] The NIOSH CIB stated that:

> NIOSH has determined that the collective weight of evidence (i.e., that from the Surgeon

> General's reports, the similarities in composition of MS and ETS, and the recent epidemiologic studies) is sufficient to conclude that ETS poses an increased risk of lung cancer and possibly heart disease to occupationally exposed workers. (p. 12)

In the excerpt above, the CIB refers to three kinds of evidence that supposedly contribute to its "collective weight of evidence." The Surgeon General's report is the first; however, the conclusions of the Surgeon General's report have been extensively criticized, as discussed above. As for the second type of "evidence" (the claimed "similarities in composition of MS and ETS"), the treatment of the available data in the NIOSH CIB is neither detailed nor complete.

Although the NIOSH CIB and the EPA Draft Risk Assessment stress the reported association between active smoking and disease in reaching their conclusions about ETS, neither report provides detailed discussions of the chemical and physical natures and differences between ETS and mainstream smoke (MS). ETS is different in both quality and quantity from both mainstream and sidestream smoke.

One major area overlooked by both the NIOSH CIB and the EPA Draft Risk Assessment is those scientific studies that actually measured levels of ETS constituents in indoor air. There is a substantial body of literature in this area which is directly relevant to considerations about non-industrial workplace exposure.

If the actual data on ETS exposures in the workplace are examined, one finds that typical workplace exposures to ETS are minimal and often below limits of detection for even the most sensitive tobacco smoke constituent monitors.

The final aspect of NIOSH's "weight of the evidence" is "recent epidemiologic studies" on ETS and lung cancer. However, its review of the spousal smoking studies is incomplete. The CIB states that eight additional spousal smoking studies have been published since 1986, when, actually, 14 have been published, most of which report associations which do not achieve statistical significance. Furthermore, the CIB acknowledges serious shortcomings in the available epidemiologic studies purporting to relate ETS exposure and lung cancer:[72]

> NIOSH recognizes that these recent epidemiologic studies have several shortcomings: lack of objective measures for characterizing and quantifying exposures, failure to adjust for all confounding variables, potential misclassification of ex-smokers as nonsmokers, unavailability of comparison groups that have not been exposed to ETS, and low statistical power.

Nevertheless, the CIB uses spousal smoking studies to reach its conclusion about occupational exposure to ETS without justifying the relevance of spousal smoking studies to workplace exposure. Of the spousal smoking studies, none actually measured

levels of ETS to which the subjects ostensibly were exposed. The NIOSH CIB also fails to address the 12 spousal smoking studies that included specific questions about workplace exposure.[14-25] Of those studies, ten reported no statistically significant increased risk of lung cancer for nonsmokers who reported ETS exposure in the workplace. The other two studies presented risk estimates which were of borderline statistical significance. Thus, the epidemiologic data are consistent with the null hypothesis, i.e., that there is no association between workplace ETS exposure and nonsmoker lung cancer.

Thus, the NIOSH CIB, which reaches conclusions about purported risks associated with exposure to ETS in the workplace, is not a comprehensive, critical review of the available data. Of even greater significance, it does not address available workplace data on exposures or potential health effects.

4. OTHER RISK ASSESSMENTS ON ETS

Two basic methods (modeling procedures) for estimating the population risk for lung cancer among nonsmokers reporting exposure to ETS have appeared in the scientific literature. The first method, adopted by the U.S. EPA in its Draft Risk Assessment (discussed above), is the Population-Attributable Risk (PAR) approach. A PAR model seeks to establish an estimate of excess

risk due to ETS exposure and is expressed as a ratio of the risk assessed for ETS to the total lung cancer risk for nonsmokers from all sources. The PAR is calculated by applying a relative risk estimate associated with reported exposure to ETS (derived from risk rates in epidemiologic studies) to the percentage of individuals believed to be exposed to ETS in the general population.

A second approach used in the literature, called the Extrapolation Method (also called the Linear Extrapolation Method or Dose-Response Extrapolation Model), combines reported risks of lung cancer for active smokers, derived from epidemiologic studies on smokers, with estimates of tobacco smoke exposure (dose) for active smokers. The risk and dose estimates for active smokers are then extrapolated downward to apply to nonsmokers. The estimated excess risk for nonsmokers exposed to ETS is obtained by dividing the lung cancer risk reported for active smokers by the ratio between the smokers' and nonsmokers' estimated average exposure to tobacco smoke.

This second approach for estimating excess lung cancer deaths among nonsmokers reportedly due to ETS exposure is exemplified by the model developed by Repace and Lowrey (1985).[73] The authors employed a linear downward extrapolation from the lung cancer risk reported for active smokers (and estimates of tobacco smoke exposure for smokers) to an exposure and residual risk

estimate for nonsmokers allegedly exposed to ETS. The model estimated lung cancer mortality among nonsmokers by dividing the reported lung cancer risk for active smokers by a ratio of estimated tobacco smoke exposure for smokers and nonsmokers. The linear dose-extrapolation model therefore requires four estimates:

1. the number of nonsmokers supposedly exposed to ETS;
2. the average ETS exposure of nonsmokers;
3. the average tobacco smoke exposure for active smokers; and
4. the lung cancer risks reported for current active smokers.

Specifically, Repace and Lowrey developed a version of a linear dose-response extrapolation model which is based upon a weighted average of nonsmoker exposure to particulates. The weighted average estimate was not derived from actual exposure data but from a model which predicts ambient concentrations of particulate matter from the number of cigarettes smoked in a given volume of air space. The authors also calculated a lung cancer risk estimate and an estimate of daily "tar" (particulate) intake for active smokers. Nonsmoker risk of lung cancer was extrapolated from those estimates to yield 555 lung cancer deaths per year attributable to ETS exposure among nonsmokers.

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Arundel, et al., (1987) refined the Repace and Lowrey extrapolation model by replacing Repace and Lowrey's estimates of particulate matter exposure for nonsmokers with actual exposure data from monitoring studies.[74] The Arundel, et al., model also rejected Repace and Lowrey's extrapolation from the dose of active smokers to the exposure of nonsmokers, and replaces the latter with an estimated retained dose of particulates for nonsmokers. Using virtually the same assumptions as Repace and Lowrey, the Arundel et al. model estimates 12 lung cancer deaths per year among 40 million male and female neversmokers.

The various assumptions and estimates employed in the Repace and Lowrey linear dose-extrapolation model have been challenged by a number of scientists.[74-78] One scientist noted that the exposure and dose levels Repace and Lowrey used were not based on actual measurements, and that actual measurements reported by other researchers ranged from "ten-to-one-hundred-fold less than that in the Repace and Lowrey model."[75]

Still other scientists have questioned the methods of analysis used in their article.[76-78] For example, the Repace and Lowrey extrapolation model assumes that the alleged carcinogenicity of tobacco smoke depends upon some (unknown) element purportedly located in the particulate phase of ETS. The model also assumes that lung cancer per unit of exposure (i.e., per mg of "tar") is

the same for mainstream smoke and ETS, an assumption which is not borne out by the scientific data regarding the chemistry of mainstream smoke and ETS. Moreover, the extrapolation model suggests that the relationship between reported risk and level of exposure is linear (i.e., dose-response), and it assumes that there is no exposure level below which lung cancer risk is absent. The dose-extrapolation model also assumes, with its suggestion of a linear dose-response from active smoking to low level exposure to ETS, that the so-called "one-hit" cancer theory, a theory that one molecule of exposure to a suspected carcinogen is sufficient to induce carcinogenesis, is valid. However, the "one-hit" model has what statisticians call a "zero intercept term," which is equivalent to assuming that lung cancer risk among nonsmokers is zero in the absence of ETS.

Even with its dubious assumptions and estimates, it is noteworthy that the linear dose-extrapolation model produces estimates of excess lung cancer deaths which are roughly an order of magnitude lower than estimates generated by the PAR model which relies on epidemiologic studies. A number of subsequently published extrapolation models, unlike that of Repace and Lowrey, have been based upon actual data and reasonable estimates of exposure.[74,79-81] These models have been unsuccessful in estimating any appreciable increased risk of lung cancer for nonsmokers reporting exposure to ETS. Indeed, extrapolation models based on estimates

of retained particulate matter generate estimates of excess risk which are as much as 20 orders of magnitude lower than estimates generated by the PAR method. Such vast ranges underscore the difference between risk estimates based on epidemiology and those based on dosimetry. This difference is so striking that even the authors of the EPA Draft Risk Assessment were unable to generate a "dose-response based on the extrapolation from mainstream to environmental tobacco smoke," and hence, relied solely upon the PAR model to support their contention of an increased risk of lung cancer among nonsmokers reportedly exposed to ETS.[82]

Despite the presence of various governmental determinations of ETS as a carcinogen, the available scientific data, including epidemiology, toxicology and dosimetry, do not support the designation of ETS as a human carcinogen.

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REFERENCES

1. U.S. Department of Health and Human Services, Public Health Service, Office on Smoking and Health, The Health Consequences of Involuntary Smoking: A Report of the Surgeon General. DHHS Publication No. (CDC) 87-8398, Washington, D.C., U.S. Government Printing Office, 1986.

2. U.S. Environmental Protection Agency, Office of Health and Environmental Assessment, Office of Atmospheric and Indoor Air Programs, Health Effects of Passive Smoking: Assessment of Lung Cancer in Adults and Respiratory Disorders in Children, External Review Draft, EPA/600/6-90/006A, May, 1990.

3. U.S. Department of Health and Human Services, Public Health Service, Centers for Disease Control, National Institute for Occupational Safety and Health, Current Intelligence Bulletin 54: Environmental Tobacco Smoke in the Workplace: Lung Cancer and Other Health Effects. DHHS (NIOSH) Publication No. 91-108, Cincinnati, Ohio, June, 1991.

4. World Health Organization, International Agency for Research on Cancer, IARC Monographs on the Evaluation of the Carcinogenic Risk of Chemicals to Humans: Tobacco Smoking, Volume 38, Lyon, 1985. (IARC Report)

5. U.S. EPA, "A Brief Summary of the Public Comments Submitted to the U.S. EPA in Response to the External Review Draft EPA 600/6-90/006A," Science Advisory Board Meeting, December 4 and 5, 1990.

6. Furst, A., "Pitfalls in Assessing Risks from Carcinogens," Bio and Env Sciences 4: 1991, 242-249.

7. Morling, J., Order Re Australian Federation of Consumer Organizations Inc. v. The Tobacco Institute of Australia Limited, Federal Court of Australia, New South Wales District Registry, General Division, No. G. 253 of 1987, February 7, 1991.

8. Tobacco Institute of Australia, Press Statement, "Tobacco Institute of Australia Limited ATS Australian Federation of Consumer Organizations Inc.," February 7, 1991.

9. Fettner, A., "Where There's Smoke There's Fire -- The New 'Passive Smoking' Rules: Sidestepping Issues by Scapegoating Smokers," Voice, 5-7, March 30, 1987.

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10. Jones, W., "Inconclusive Evidence on the Harmful Effects of Smoking," U.S. Congressional Record - Extension of Remarks, E489-E490, February 18, 1987.

11. Schwartz, S.L. and Balter, N.J., "ETS-Lung Cancer Epidemiology: Supportability of Misclassification and Risk Assumptions," Environmental Technology Letters 9: 479-490, 1988.

12. Uberla, K., "Epidemiology: Its Scope and Limitations for Indoor Air Quality." In: Indoor Air Quality: Symposium. Buenos Aires, National Academy of Sciences of Buenos Aires, 45-60, 1989.

13. Mantel, N., "Lung Cancer and Passive Smoking," British Medical Journal 294: 440, 1987.

14. Kabat, G. and Wynder, E., "Lung Cancer in Nonsmokers," Cancer 53(5): 1214-1221, 1984.

15. Garfinkel, L., Auerbach, O. and Joubert, L., "Involuntary Smoking and Lung Cancer: A Case-Control Study," Journal of the National Cancer Institute 75(3): 463-469, 1985.

16. Wu, A., Henderson, B.E., Pike, M.C. and Yu, M.C., "Smoking and Other Risk Factors for Lung Cancer in Women," Journal of the National Cancer Institute 74(4): 747-751, 1985.

17. Janerich, D., Thompson, W.D., Varela, L.R., Greenwald, P., Chorost, S., Tucci, C., Zaman, M.B., Melamed, M.R., Kiely, M. and McKneally, M.F., "Lung Cancer and Exposure to Tobacco Smoke in the Household," New England Journal of Medicine 323: 632-636, 1990.

18. Kabat, G.C., "Epidemiologic Studies of the Relationship Between Passive Smoking and Lung Cancer." In: Toxicology Forum: 1990 Annual Winter Meeting. Washington, D.C., 187-199, February 19-21, 1990.

19. Fontham, E.T.H., Correa, P., Wu-Williams, A., Reynolds, P., Greenberg, R.S., Buffler, P.A., Chen, V.W., Boyd, P., Alterman, T., Austin, D.F., Liff, J. and Greenberg, S.D., "Lung Cancer in Nonsmoking Women: A Multicenter Case-Control Study," Cancer Epidemiology, Biomarkers & Prevention 1: 35-43, 1991.

20. Lee, P.N., Chamberlain, J. and Alderson, M.R., "Relationship of Passive Smoking to Risk of Lung Cancer and Other Smoking-Associated Diseases," British Journal of Cancer 54: 97-105, 1986.

2501049803

21. Svensson, C., Pershagen, G. and Klominek, J., "Smoking and Passive Smoking in Relation to Lung Cancer in Women," Acta Oncologica 28(5): 623-639, 1989.

22. Kalandidi, A., Katsouyanni, K., Voropoulou, N., Bastas, G., Saracci, R. and Trichopoulos, D., "Passive Smoking and Diet in the Etiology of Lung Cancer Among Non-Smokers," Cancer Causes and Control 1: 15-21, 1990.

23. Koo, L.C., Ho, J.H.-C., Saw, D. and Ho, C.Y., "Measurements of Passive Smoking and Estimates of Lung Cancer Risk Among Non-Smoking Chinese Females," International Journal of Cancer 39: 162-169, 1987.

24. Shimizu, H., Morishita, M., Mizuno, K., Masuda, T., Ogura, Y., Santo, M., Nishimura, M., Kunishima, K., Karasawa, K., Nishiwaki, K., Yamamoto, M., Hisamichi, S. and Tominaga, S., "A Case-Control Study of Lung Cancer in Nonsmoking Women," Tohoku Journal of Experimental Medicine 154: 389-97, 1988.

25. Wu-Williams, A.H., Dai, X.D., Blot, W., Xu, Z.Y., Sun, X.W., Xiao, H.P., Stone, B.J., Yu, S.F., Feng, Y.P., Ershow, A.G., Sun, J., Fraumeni, J.F and Henderson, B.E., "Lung Cancer Among Women in North-East China," British Journal of Cancer 62: 982-987, 1990.

26. Hirayama, T., "Non-Smoking Wives of Heavy Smokers Have a Higher Risk of Lung Cancer: A Study from Japan," British Medical Journal 282: 183-185, 1981.

27. Trichopoulos, D., Kalandidi, A., Sparros, L. and MacMahon, B., "Lung Cancer and Passive Smoking," International Journal of Cancer 27(1): 1-4, 1981.

28. Garfinkel, L., "Time Trends in Lung Cancer Mortality Among Nonsmokers and a Note on Passive Smoking," Journal of the National Cancer Institute 66(6): 1061-1066, 1981.

29. Chan, W.C. and Fung, S.C., "Lung Cancer in Non-Smokers in Hong Kong." In: Cancer Campaign Vol. 6, Cancer Epidemiology. E. Grundmann (ed.). Stuttgart, Gustav Fischer Verlag, 199-202, 1982.

30. Correa, P., Pickle, L.W., Fontham, E., Lin, Y. and Haenszel, W., "Passive Smoking and Lung Cancer," Lancet II: 595-597, 1983.

31. Buffler, P.A., Pickle, L.W., Mason, T.J. and Contant, C., "The Causes of Lung Cancer in Texas." In: Lung Cancer:

Causes and Prevention. M. Mizell and P. Correa (eds.). Deerfield Beach, Verlag Chimie International, 83-99, 1984.

32. Gillis, C.R., Hole, D.J., Hawthorne, V.M. and Boyle, P., "The Effect of Environmental Tobacco Smoke in Two Urban Communities in the West of Scotland." In: ETS - Environmental Tobacco Smoke: Report from a Workshop on Effects and Exposure Levels. R. Rylander, Y. Peterson and M.-C. Snella (eds.). Published simultaneously in European Journal of Respiratory Disease, Supplement 133, Volume 65, 121-126, 1984.

33. Lam, W.K., A Clinical and Epidemiological Study of Carcinoma of Lung in Hong Kong, M.D. Thesis Submitted to the University of Hong Kong, 1985.

34. Akiba, S., Kato, H. and Blot, W.J., "Passive Smoking and Lung Cancer Among Japanese Women," Cancer Research 46: 4804-4807, 1986.

35. Brownson, R.C., Reif, J.S., Keefe, T.J., Ferguson, S.W. and Pritzl, J.A., "Risk Factors for Adenocarcinoma of the Lung," American Journal of Epidemiology 125(1): 25-34, 1987.

36. Gao, Y.-T., Blot, W.J., Zheng, W., Ershow, A.G., Hsu, C.W., Levin, L.I., Zhang, R. and Fraumeni, J.F., "Lung Cancer Among Chinese Women," International Journal of Cancer 40: 604-609, 1987.

37. Humble, C.G., Samet, J.M. and Pathak, D.R., "Marriage to a Smoker and Lung Cancer Risk," American Journal of Public Health 77(5): 598-602, 1987.

38. Lam, T.H., Kung, I.T.M., Wong, C.M., Lam, W.K., Kleevens, J.W.L., Saw, D., Hsu, C., Seneviratne, S., Lam, S.Y., Lo, K.K. and Chan, W.C., "Smoking, Passive Smoking and Histological Types in Lung Cancer in Hong Kong Chinese Women," British Journal of Cancer 56(5): 673-678, 1987.

39. Pershagen, G., Hrubec, Z. and Svensson, C., "Passive Smoking and Lung Cancer in Swedish Women," American Journal of Epidemiology 125(1): 17-24, 1987.

40. Geng, G.-Y., Liang, T.H., Zhang, A.Y. and Wu, G.L., "On the Relationship Between Smoking and Female Lung Cancer." In: Smoking and Health 1987. M. Aoki, S. Hisamichi and S. Tominaga (eds.). Amsterdam, Excerpta Medica, 483-486, 1988.

41. Inoue, R. and Hirayama, T., "Passive Smoking and Lung Cancer in Women." In: Smoking and Health 1987. M. Aoki, S.

2501049805

Hisamichi and S. Tominaga (eds.). Amsterdam, Excerpta Medica, 283-285, 1988.

42. Sobue, T., Suzuki, R., Nakayama, N., Inubuse, C., Matsuda, M., Doi, O., Mori, T., Furuse, K., Fukuoka, M., Yasumitsu, T., Kuwabara, O., Ichigaya, M., Kurata, M., Kuwabara, M., Nakahara, K., Endo, S. and Hattori, S., "Passive Smoking Among Nonsmoking Women and the Relationship Between Indoor Air Pollution and Lung Cancer Incidence -- Results of a Multicenter Case Controlled Study," Gan to Rinsho 36(3): 329-333, 1990.

43. Liu, Z., He, X. and Chapman, R.S., "Smoking and Other Risk Factors for Lung Cancer in Xuanwei, China," International Journal of Epidemiology 20(1): 26-31, 1991.

44. Wynder, E.L. and Kabat, G.C., "Environmental Tobacco Smoke and Lung Cancer: A Critical Assessment." In: Indoor Air Quality. H. Kasuga (ed.). Berlin, Heidelberg, Springer-Verlag, 5-15, 1990.

45. Gori, G.B. and Mantel, N., "Mainstream and Environmental Tobacco Smoke," Regulatory Toxicology and Pharmacology 14: 88-105, 1991.

46. Kilpatrick, S., "Misclassification of Environmental Tobacco Smoke Exposure: Its Potential Influence on Studies of Environmental Tobacco Smoke and Lung Cancer," Toxicology Letters 35: 163-168, 1987.

47. Friedman, G., Petitti, D.B. and Bawol, R.D., "Prevalence and Correlates of Passive Smoking," American Journal of Public Health 73(4): 401, 1983.

48. Pron, G.E., Burch, J.D., Howe, G.R. and Miller, A.B., "The Reliability of Passive Smoking Histories Reported in a Case-Control Study of Lung Cancer," American Journal of Epidemiology 127(2): 267-273, 1988.

49. Schenker, M., Hammond, K., Samuels, S., Kado, N. and Woskie, S., "Assessment of Environmental Tobacco Smoke Exposure in Epidemiologic Studies," Chest 91(2): 313-314, 1987. Abstract.

50. Lerchen, M.L. and Samet, J.M., "An Assessment of the Validity of Questionnaire Responses Provided by a Surviving Spouse," American Journal of Epidemiology 123(3): 481-489, 1986.

51. Sandler, D.P. and Shore, D.L., "Quality of Data on Parents' Smoking and Drinking Provided by Adult Offspring," American Journal of Epidemiology 124(5): 768-778, 1986.

52. Leaderer, B., "Assessing Exposures to Environmental Tobacco Smoke," Risk Analysis 10(1): 19-26, 1990.

53. Shimizu, Y., Namekata, T. and Takemoto, K., "Epidemiological Issues on Involuntary Smoking and Lung Cancer." In: Indoor Air Quality. H. Kasuga (ed.). Berlin, Heidelberg, Springer-Verlag, 323-332, 1990.

54. National Research Council, National Academy of Sciences, "Current and Anticipated Applications." In: Human Exposure Assessment for Airborne Pollutants: Advances and Opportunities. Washington, D.C., National Academy Press, 207-218, 1991.

55. Vaughan, W. and Hammond, K., "Impact of 'Designated Smoking Area' Policy on Nicotine Vapor and Particle Concentrations in a Modern Office Building," J Air Waste Manage Assoc 40: 1012-1017, 1990.

56. Hedge, A., et al., "Building Ventilation and Smoking Policy Effects on Indoor Air Quality and Employee Comfort and Health." In: Indoor Air '90: Proceedings of the Fifth International Conference on Indoor Air Quality and Climate. Toronto, Canada, Volume 1, 739-744, July 29-August 3, 1990.

57. Sterling, T. and Mueller, B., "Concentrations of Nicotine, RSP, CO and CO_2 in Nonsmoking Areas of Offices Ventilated by Air Recirculated from Smoking Designated Areas," Am Ind Hyg Assoc J 49(9): 423-426, 1988.

58. Sterling, T., et al., "Exposure to Environmental Tobacco Smoke in the Non Industrial Workplace Under Different Conditions of Ventilation and Smoking Regulation." In: Present and Future of Indoor Air Quality. C.J. Bieva, et al. (eds.). Elsevier Science Publishers, Amsterdam, 111-118, 1989.

59. Malmfors, T., et al., "Air Quality in Passenger Cabins of DC-9 and MD-80 Aircraft," Environ Technol Letters 10: 613-628, 1989.

60. Oldaker, G., et al., "Estimation of Effect of Environmental Tobacco Smoke on Air Quality Within Passenger Cabins of Commercial Aircraft II." In: Indoor Air Quality and Ventilation, F. Lunau and G. Reynolds (eds.). London, Selper Ltd., 447-454, 1990.

61. Oldaker, G. and Conrad, F., "Estimation of the Effect of Environmental Tobacco Smoke on Air Quality Within Passenger Cabins of Commercial Aircraft," Environ Sci Technol 21: 994-999, 1987.

2501049807

62. Sterling, T., "ETS Concentrations Under Different Conditions of Ventilation and Smoking Regulation." In: Indoor and Ambient Air Quality. R. Perry and P. Kirk (eds.). London, Selper Ltd., 89-98, 1988.

63. Anonymous, "A Brief Summary of the Public Comments Submitted to the U.S. EPA in Response to the External Review Draft EPA/600/6-90/006A," submitted to the U.S. Environmental Protection Agency, Science Advisory Board Meeting, December 4-5, 1990.

64. Baker, R. and Proctor, C., "The Origins and Properties of Environmental Tobacco Smoke," Env Int 16: 231-245, 1990.

65. Lofroth, G., et al., "Characterization of Environmental Tobacco Smoke," Env Sci Technol 23: 610-614, 1989.

66. Reasor, M., and Will, J., "Assessing Exposure to Environmental Tobacco Smoke: Is It Valid to Extrapolate from Active Smoking?" Journal of Smoking Related Diseases 2(1): 111-127, 1991.

67. Proctor, C. and Dymond, H., "The Measurement of ETS Through Adsorption/Desorption Procedures." In: Indoor Air Quality. H. Kasuga (ed.). Berlin, Heidelberg, Springer-Verlag, 82-89, 1990.

68. Nystrom, C., et al., "Assessing the Impact of Environmental Tobacco Smoke on Indoor Air Quality: Current Status." In: Proceedings of the ASHRAE Conference, IAQ '86. Atlanta, Georgia, 213-233, April 20-23, 1986.

69. Scherer, G., et al., "Importance of Exposure to Gaseous and Particulate Phase Components of Tobacco Smoke in Active and Passive Smokers," Occup Env Health 62: 459-466, 1990.

70. Fleiss, J.L. and Gross, A.J., "Meta-Analysis in Epidemiology, with Special Reference to Studies of the Association Between Exposure to Environmental Tobacco Smoke and Lung Cancer: A Critique," Journal of Clinical Epidemiology 44(2): 127-139, 1991.

71. Letzel, H. and Uberla, K., "Meta-Analyses on Passive Smoking and Lung Cancer." In: Indoor Air Quality. H. Kasuga (ed.). Berlin, Heidelberg, Springer-Verlag, 316-322, 1990.

72. Letter to Dr. J. Donald Millar, Director, National Institute for Occupational Safety and Health, from Samuel D. Chilcote, Jr., President, The Tobacco Institute, August 1, 1991.

73. Repace, J. and Lowrey, A., "A Quantitative Estimate of Nonsmokers' Lung Cancer Risk from Passive Smoking," Environment International 11(1): 3-22, 1985.

74. Arundel, A., Sterling, T. and Weinkam, J., "Never Smoker Lung Cancer Risks from Exposure to Particulate Tobacco Smoke," Environment International 13: 409-426, 1987.

75. Lebowitz, M.D., "The Potential Association of Lung Cancer with Passive Smoking," Environment International 12: 3-9, 1986.

76. Johnson, C. and Letzel, H., "Letter to the Editors," Environment International 12: 21-22, 1986.

77. Burch, P.R.J., "Health Risks of Passive Smoking: Problems of Interpretation," Environment International 12: 23-28, 1986.

78. Kilpatrick, S.J., "Letter to the Editors," Environment International 12: 29-31, 1986.

79. Darby, S. and Pike, M., "Lung Cancer and Passive Smoking: Predicted Effects from a Mathematical Model for Cigarette Smoking and Lung Cancer," British Journal of Cancer 58: 825-831, 1988.

80. Gori, G. and Mantel, N., "Mainstream and Environmental Tobacco Smoke," Regulatory Toxicology and Pharmacology 14: 88-105, 1991.

81. McAughey, J., et al., "Respiratory Deposition of Environmental Tobacco Smoke." In: Indoor Air '90: Proceedings of the Fifth International Conference on Indoor Air Quality and Climate. Toronto, Canada, Volume 2, 361-366, July 29-August 3, 1990.

82. Bayard, S., Statement, The U.S. Environmental Protection Agency Science Advisory Board Hearing on Health Effects of Passive Smoking: Assessment of Lung Cancer in Adults and Respiratory Disorders in Children, External Review Draft, EPA/600/6-90/006A, 116-117, December 4, 1990. Transcript.

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III. SMOKING POLICY ISSUES

A. Employers Should Consider Potential Adverse Consequences of Instituting a Workplace Smoking Ban Absent an Overall Indoor Air Quality Evaluation

The foregoing discussion demonstrates that ETS is both quantitatively and qualitatively different from mainstream smoke; that nonsmoker exposure to ETS under normal, everyday conditions is minimal; and, most importantly, that the claim that ETS causes disease in nonsmokers is not conclusively supported by the scientific data.

Moreover, investigations of buildings that are alleged to be "sick" consistently indicate that tobacco smoke is not a major contributing factor in an overwhelming majority of air quality problems. Four large databases of information on the possible causes of sick building syndrome exist in North America.[1] The similarities in the data and conclusions from these databases are remarkable. They suggest that nearly one-half of all sick buildings suffer from inadequate fresh air ventilation and approximately one-third suffer from inadequate air circulation. Improper maintenance of blowers and filters further results in poor filtration and contaminated systems (dirty air ducts, humidifiers, etc.). Importantly, these groups also note that few of the complaints are traceable to specific pollutant sources in the building.[2] Perhaps contrary to widely held impressions, tobacco smoke is related to

only 2-4% of the complaints in each of the databases on sick buildings.

In light of these facts, an employer's decision to voluntarily ban smoking without investigating overall indoor air quality could have unanticipated adverse legal implications.

After a smoking ban has been implemented, invisible toxic substances unrelated to ETS may remain in the air and injure employees.[3] The injured employees may allege that, as a result of the smoking ban, they were misled into thinking that indoor air quality had been significantly improved when in fact it had not. They may further allege that the smoking ban was counterproductive to improving indoor air quality because tobacco smoke would have served as a constant indicator of inadequate ventilation that may have led to earlier detection of the problem. Injured employees may even accuse the employer of taking the relatively inexpensive approach of banning smoking to avoid learning about or dealing with the "real cause" of complaints about indoor air quality.

In addition, the employer could potentially face complaints or even suits from smokers who argue that the ban was unreasonable and unjustified because it was not rationally, factually, or objectively related to improvement of air quality in the workplace.

B. **Finland Should Refrain From Taking Action With Respect to ETS That May Be Inconsistent With the EC's Ultimate Approach to IAQ Issues.**

Finland applied for membership to the European Economic Community (EC) on March 18, 1992. The governmental units of the EC have been, and continue to be, actively involved with issues relating to the environment, indoor air quality, and occupational safety and health.

For example, the Council of the European Communities has, over the past 15 years, initiated three action programs on safety and health at work and has declared 1992 the European Year of Safety at Work. On 30 September 1991, the Commission of the European Communities submitted a proposal for a council regulation establishing a European Agency for Safety and Health at Work.[4] In its activities, the Agency is to cooperate with international organizations such as the World Health Organization (WHO) and the International Labor Office (ILO). The Agency's duties are to include the collection and coordinated exchange of information on an international level, the provision of technical and scientific information for the commission's regulatory efforts in the area, and the monitoring of the application of legislative measures in the area of workplace safety and health.

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Although the EC's activities have encompassed ETS, the EC has not, to the best knowledge of the undersigned, designated ETS as a carcinogen. As a potential member of the EC, Finland should not take action with respect to ETS that may be inconsistent with the EC's ultimate approach to issues related to indoor air quality and occupational safety and health.

REFERENCES

1. Organizations that have investigated sick buildings include the National Institute for Occupational Safety and Health (NIOSH), a U.S. federal agency, which has investigated more than 500 complaints in the U.S.; investigators from Health and Welfare Canada who have examined more than 1,300 so-called "sick buildings"; a private firm in the U.S. involved in the identification and mitigation of pollution in public and commercial buildings -- Healthy Buildings International (formerly ACVA Atlantic, Inc.) -- which has a database of more than 350 building investigations from around the world; and another private investigator, TDS Limited and Associates in Canada, who has developed a database detailing approximately 400 sick buildings.

2. The U.S. EPA has identified a whole host of potential sources of indoor pollutants which include formaldehyde from pressed wood products; other organics from building materials, carpeting and other office furnishings, cleaning materials and activities, paints, adhesives, copying machines; biological contamination from dirty ventilation systems; and pesticides from pest management systems. EPA does not consider indoor pollutants such as radon and asbestos to be among the causes of sick buildings, primarily because SBS and BRI problems are associated with acute (short-term) symptoms, while radon and asbestos are of concern because of their chronic (long-term) health effects. EPA, "Indoor Air Facts No. 4: Sick Buildings," July 1988.

3. See generally G. Robertson, "Indoor Pollution: Sources, Effects and Mitigation Strategies," Environmental Tobacco Smoke: Proceedings of the International Symposium of McGill University 1989, pp. 333-366, 1990.

4. 34 O.J. Eur. Comm. (No. C271) 3 (1991).

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